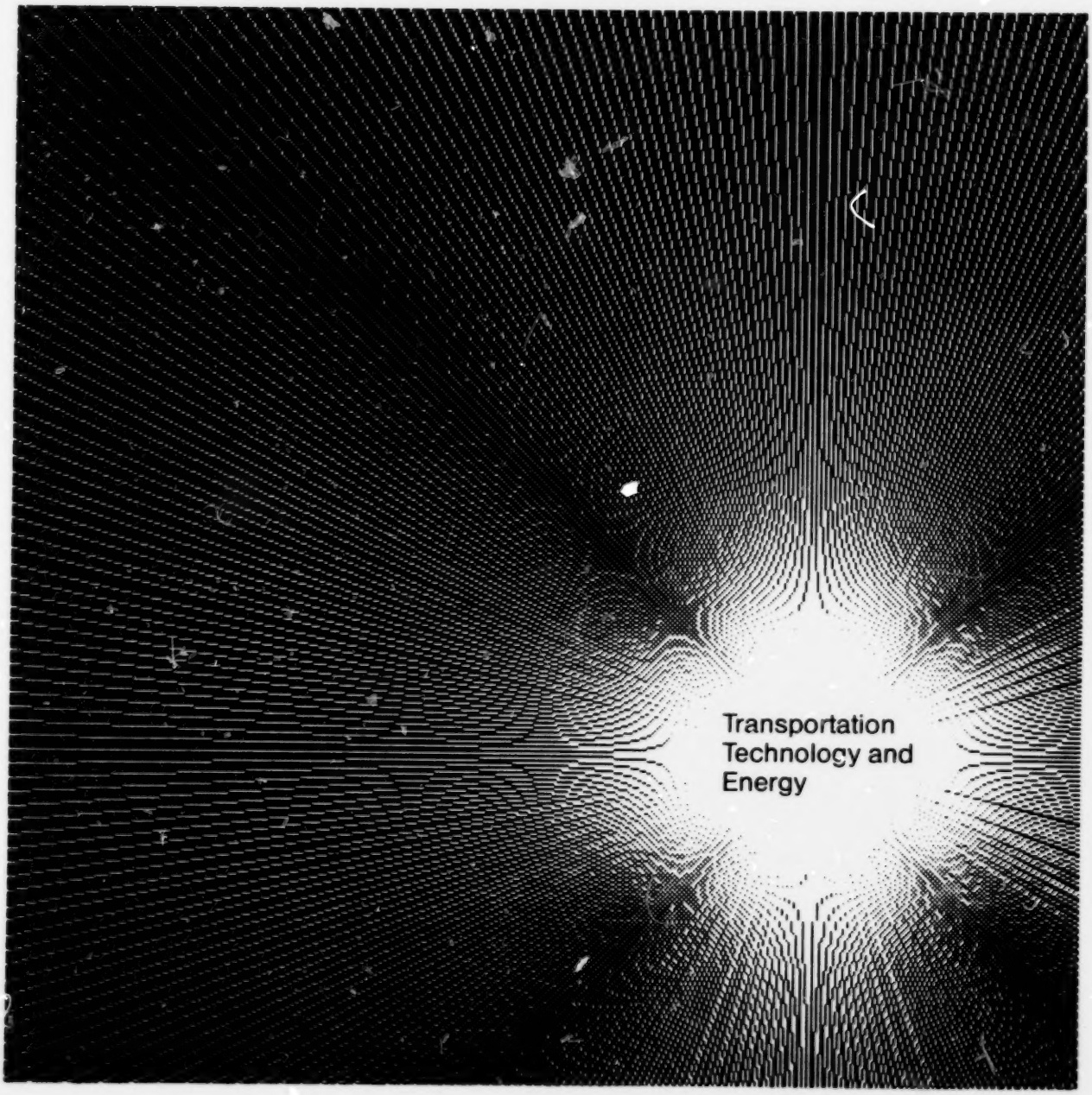
Ontario

Ministry of
Transportation and
Communications

Transportation
Technology and
Energy Branch



Electric Vans In Courier Service: Six-Month Progress Report

EV-87-01

EV-87-01

Electric Vans In Courier Service: Six-Month Progress Report

D. Hsu
Reasearch Engineer
Electric Vehicles Section

J. Duncan
Head, Electric Vehicles Section
Automotive Technology and Systems Office

Published by:
Transportation Technology and Energy Branch
Ontario Ministry of Transportation and Communications
Hon. Ed Fulton, Minister
David Hobbs, Deputy Minister

Published without prejudice
as to the application of the findings.
Crown copyright reserved; however, this
document may be reproduced for non-commercial
purposes with attribution to the ministry.

For additional copies, write:
The Editor, Technical Publications
Ontario Ministry of Transportation and Communications
1201 Wilson Avenue
Downsview, Ontario
Canada M3M 1J8
(416) 235-3466

September 1986

Technical Report Documentation Page

MTC Report Number EV-87-01	ISBN Number:	Other Document Number:	Date: Sept 1987

Title: Electric Vans In Courier Service
Six-Month Progress Report

Authors (name, title and/or organization):
D. Hsu, Research Engineer
J. Duncan, Head, Electric Vehicles Section

Published by:
Automotive Technology and Systems Office
Transportation Technology and Energy Branch
MTC

Client Group:
Ontario Centre for Automotive Parts Technology

Participating Agencies:
Ministry of Energy
Ministry of Industry, Trade and Technology

Abstract:

The Ontario Ministry of Transportation and Communications is conducting an over-the-road evaluation of two General Motors Griffon electric vans for the Ontario Centre for Automotive Parts Technology. The objective of the program is to establish an understanding of the behaviour, reliability, cost, and operational limitations of electric vehicles in routine urban traffic in Canada.

This report describes the first six months of vehicle operation in courier service. Operational results are given.

Key Words:

Comments:

Distribution:

Copyright Status: Crown

TABLE OF CONTENTS

	PAGE
ACKNOWLEDGEMENTS	iv
EXECUTIVE SUMMARY	v
1/ INTRODUCTION	1
2/ OBJECTIVE	2
3/ VEHICLE DESCRIPTION	3
4/ COURIER SERVICES	4
5/ BATTERY CHARGE	5
6/ PROPULSION SYSTEM MAINTENANCE	6
7/ VEHICLE MAINTENANCE	7
8/ DYNAMOMETER TEST	8
9/ OPERATION DATA COLLECTION	9
9.1/ Vehicle Distance.	9
9.2/ Electricity	9
9.3/ Heater Fuel	9
9.4/ Maintenance	9
10/ OPERATION RESULT	10
10.1/ Vehicle Distance	10
10.2/ Electricity Consumption.	10
10.3/ Human Factor	10
10.4/ Heater Fuel Consumption.	10
10.5/ Maintenance Cost	10
10.6/ Operation Cost	11
11/ PASSENGER SURVEY	12
12/ DYNAMOMETER TEST RESULTS	13
13/ ABNORMAL FACTORS AFFECTING RESULTS	14
13.1/ Service Days	14
13.2/ Energy Consumption	14
13.3/ Labour Cost.	14
13.4/ Water Consumption.	14
14/ CONCLUSION	15
15/ REFERENCES	32
APPENDICES	
A/ Load Research Records	33
B/ Passenger Survey Questionnaire.	36

LIST OF TABLES

PAGE

1/ Courier Service. 16
2/ Operation Data of EV11 and EV12. 17
3/ Causes for Loss of Full-Day Service. 18
4/ Energy Consumption versus Drivers. 19
5/ Battery Pack Water Consumption 20
6/ Labour Cost on Maintenance and Repair. 21
7/ Operation Cost 22
8/ Passenger Survey Findings. 23
9/ Dynamometer Test 24

LIST OF FIGURES

1/ Courier Service Routes 25
2/ Courier Service Regular Stops -- Queen's Park Area 26
3/ Courier Service Regular Stops -- MTC Downsview Complex 27
4/ Power Demand at District 42 Charger -- July 10, 1986 28
5/ Power Demand at Government Garage Charger -- July 10, 1986 . . . 29
6/ Power Demand at District 42 Charger -- July 23, 1986 30
7/ Power Demand at Government Garage Charger -- July 23, 1986 . . . 31

ACKNOWLEDGEMENTS

The authors would like to thank the Load Research Section of the Rates and Strategy Conservation Department in the Market Services and Development Division of Ontario Hydro for their assistance in providing load research recorder equipment and information retrieval services for the Griffon Electric Van Test Program.

The after sales support from the Lucas Chloride Electric Vehicle Systems, especially the North American office, has always been to our great satisfaction and is very much appreciated.

EXECUTIVE SUMMARY

This report summarizes the six-month operational results of the two Griffon electric vans in courier service between the Queen's Park complex and the Ministry of Transportation and Communications (MTC), Downsview, a distance of 17 km each way.

The results of the six-month period from May 14, 1986 to November 13, 1986 are summarized as follows:

- A total driving distance of 22 361 km was logged by the two vehicles.
- The electricity consumption per unit distance was 0.50 kWh/km and the electricity cost was 1.9¢/km.
- The operational cost which includes electricity, heater fuel, battery water, and maintenance labour was 11.95¢/km.
- The required overnight battery charge was about eight hours.
- The typical daily opportunity charge time taken by each vehicle was about 80 minutes.
- Seventy-one percent of the passengers surveyed considered the ride uncomfortable.
- Eighty-five percent of the passengers surveyed were in favour of such a demonstration program.

1/ INTRODUCTION

On May 14, 1986 the two Griffon one-tonne electric vans were put into courier service, operated by the Government Repair Garage, Engineering Equipment Office. The Automotive Technology and Systems Office was responsible for the maintenance of the electric drive systems of the two vehicles. The maintenance of systems common to conventional vehicles was shared by the Government Repair Garage at Bay Street and the MTC District 42 Garage. The vans were paid for by the Ministry of Energy, and the program was managed by the Ontario Centre for Automotive Technology.

This report summarizes the six-month operational results gained from the daily courier service operation of the two electric vehicles.

2/ OBJECTIVE

The program is being carried out to establish an understanding of the behaviour, reliability, cost and operational limitations of the two Griffon electric vans as they perform in daily scheduled courier service in Canadian conditions.

3/ VEHICLE DESCRIPTION

The two Griffon vans are licensed as Ontario government-owned vehicles. The licence plates are EV11 and EV12 as to distinquish them from the normal vehicle fleet. Both vehicles are equipped with nine seats. There is approximately 0.85 m^3 of cargo space behind the rear seats. Further details of both vehicles are listed in "Electric Vans Progress Report," published in October 1986 [1].

4/ COURIER SERVICES

The courier services operation is provided and controlled by the Government Repair Garage, Equipment Engineering Office of the Ministry of Transportation and Communications (MTC).

The operation was identified as the most suitable for electric drive systems within the MTC fleet operation. With agreement and co-operation from the Equipment Engineering Office, the two electric vans were assigned to the courier service on May 14, 1986.

The courier service is a scheduled shuttle run between the ministry at Downsview and the Queen's Park Government Repair Garage. Two vehicles are used for the operation. Table 1 gives the courier service time schedule. Figure 1 gives the route map. Daily total distance covered by one vehicle is in the range between 92 km (57 miles) to 101 km (63 miles).

The actual route between the two points depends on the operator's choice and the number of stops required for a particular run. In general, operators are advised to avoid the use of freeway sections in order to conserve energy. The time taken for one trip varies from 25 to 45 minutes depending on traffic conditions, number of stops, and time spent picking up mail and parcels at both ends. Figures 2 and 3 show the daily regular stops for MTC Downsview complex and Queen's Park area.

In order to compensate for the different duty cycles and vehicle loading patterns, the vehicle starting points were exchanged several times within the reporting period. This also meant exchanging drivers. Thus the effects of different vehicle loading patterns, duty cycles and driving habits are minimized. On the day of change over, both vehicles would miss one or two trips on that day.

5/ BATTERY CHARGE

Three types of battery charge are used in this program:
1/ overnight charge
2/ trickle charge
3/ opportunity charge

The overnight charge always takes place at the vehicle depot after the vehicle finishes its last daily run. In general, charging starts at around 4:15 pm and ends at midnight.

A trickle charge occurs about five-and-a-half hours after the end of the overnight charge. If the vehicle is left on the charger, the trickle charge will repeat itself every five-and-a-half hours as is the case during weekends and holidays.

The opportunity charge is the term used when the vehicle is plugged to the charger between runs. The opportunity charges are required to extend the vehicle's daily driving range from its normal range of 80 km (50 miles) to over 97 km (60 miles). When opportunity charging, vehicle operators normally use the charger at the Bay Street government repair garage, but occasionally also use the charger at District 42 garage at MTC's Downsview complex.

6/ PROPULSION SYSTEM MAINTENANCE

The vehicle propulsion system consists of the following:

- battery pack
- traction motor
- system interface module
- controller assembly

No regular services were scheduled for the latter two subsystems. The recommended service schedule for topping up the battery pack is once every three weeks. For operational reasons, the topping up of the battery pack was set on a two-week interval. This gives a built-in one-week delay margin in case the autofil trolley or the battery pack watering system develop problems.

The carbon brushes were inspected and the air filters of the traction motor cleaned whenever the vehicles were removed from courier service for maintenance work on other items.

7/ VEHICLE MAINTENANCE

All required work, excluding that done on the propulsion system, was considered vehicle maintenance. There was no fixed maintenance schedule for this work, but the two vehicles were closely monitored and removed from courier service whenever attention was required either for improvement or repair. The vehicles were visually inspected whenever available, and appropriate maintenance was performed as required.

8/ DYNAMOMETER TEST

Both EV11 and EV12 were removed from courier service and tested on the Clayton mechanical dynamometer for the 56 km/h (35 mph) constant speed range and for the SAE J227a C cycle range. The main purpose of these tests was to establish the performance level of the traction battery pack for future reference.

During this reporting period, only EV12 had successfully completed both tests. The testing of the EV11 was completed in December 1986, and the results are included in this report for comparison.

9/ OPERATION DATA COLLECTION

9.1/ Vehicle Distance

Vehicle operators were required to complete a daily report, recording the vehicle's daily distance travelled, and the operator's comments regarding the vehicle.

9.2/ Electricity

The power requirement and energy consumption of the battery chargers are recorded on a magnetic cassette tape, which is changed monthly. The data retrieval and analysis were performed by the Load Research Section of the Rates and Strategic Conservation Department in the Market Services and Development Division of Ontario Hydro. Two forms and a summary sheet of computer printout were produced monthly.

The summary sheet gives the total monthly energy consumption, peak-power demand, and the time the peak-power demand occurred. The power demand analysis printout listed the power demand in 15-min intervals as well as the total daily energy consumption. The printout of the energy consumption per 15-min interval is expressed in the number of pulses with the conversion factor equal to 0.00720 kWh per pulse. A sample of each of the three printouts is given in Appendix A Load Research Records.

9.3/ Heater Fuel

Both winterized diesel oil and kerosene were used for the heater. The diesel oil was obtained from a MTC pump which sells at a price lower than commercial pump stations, while the kerosene was purchased from a local hardware store. The recorded six months occurred during the warm season; therefore, consumption of the heater fuel was negligible and $20 for fuel costs was arbitrarily added into the total operation cost.

9.4/ Maintenance

Maintenance common to conventional vehicles such as tire changing, brake inspection and servicing has not yet been required, but will be accounted for when it occurs. Washing and cleaning the vehicle has not been considered maintenance.

The maintenance registered for the reporting period was mainly related to electric drive systems: traction-battery pack, motor, brake vacuum pump, motor controller, and heater.

10/ OPERATION RESULT

10.1/ Vehicle Distance

EV11 accumulated 11 503 km (7184 miles) and EV12 accumulated 10 858 km (6747 miles) in the first six-month period which totalled 126 working days. EV11 was in full-day service for 106 days and EV12, for 91 days.

Table 2 lists related operation data of the two vehicles. Table 3 gives a breakdown of the days that the vehicle did not complete all three return trips.

10.2/ Electricity Consumption

The maximum electric power demand by the charger was 7.3 kW. The maximum daily energy consumption per vehicle was 58.16 kWh. The overall electricity consumption of EV11 and EV12 for the six-month period was 5747 kWh and 5330 kWh respectively. Details of the electricity consumption of the two vehicles are included in Table 2. Figures 4 to 7 give the power demands and energy consumptions of two respective days at Bay Street government garage and District 42 garage chargers.

10.3/ Human Factor

The driving habits of the two regular operators were quite different. Driver 1 used the freeways and often drove more than 105 km a day, while driver 2 used short cuts in the residential areas and often drove less than 100 km a day. Table 4 shows the difference between each driver on the two vehicles. It is interesting to see that the energy consumption per unit distance is lower with driver 1 for both vehicles.

10.4/ Heater Fuel Consumption

The $20 allotted for heater fuel in the operational cost was actually used for filling up the fuel tanks, because the heaters were seldom used. The actual amount of fuel consumption for the period is unknown.

10.5/ Maintenance Cost

The maintenance cost for the operation consists of two parts. Part one is the cost of de-ionized water used for topping up the traction-battery pack. Part two is the total labour cost for the maintenance and repair

work. Part one is summarized in Table 5 and part two is listed in Table 6.

10.6/ Operation Cost

Operation cost, summarized in Table 7, is the sum of electricity, heater fuel, battery water, and maintenance costs. The maintenance man-hours spent on trouble-shooting and repairing the identical problem on the second vehicle, in most cases, was less than half of the time spent on the first vehicle; therefore, the averaged cost column "EVs" was included in Table 7.

11/ PASSENGER SURVEY

A passenger survey was conducted for two weeks after the two electric vans had been in courier service for two months. A copy of the survey questionnaire is presented in Appendix B. The 29 returns were separated into three groups according to the first answer:

1/ occasional riders
2/ riders who took one ride each week
3/ riders who took more than one ride each week

Table 8 summarizes the results of the questionaire both collectively and by these three groups. The table contains two parts, one expressing the results in number of answers and the other in percentages. Answers that did not respond directly to the questions or included conditions were considered neither as "Yes" nor as "No" and were grouped as neutral ("neu") in the table.

Question 9 of the survey form asked for general comments on the courier service. Typical responses were:

- the seats are not comfortable
- suspension is hard
- please modify the suspension
- good test
- serves the purpose

12/ DYNAMOMETER TEST RESULTS

The test results of EV11 and EV12 on the Clayton mechanical dynamometers are listed in Table 9. The 56 km/h (35 mph) constant speed dc energy consumption of 210 Wh/km is the same as the test result conducted by Tennessee Valley Authority (TVA) [2].

The SAE J227a C cycle dc energy consumption of 175 Wh/cycle or 324 Wh/km is much higher than 250 Wh/km obtained by TVA in a track test. The possible reasons for the differences are as follows:

- dynamometer test versus track test
- different acceleration pattern
- different test cut-off criteria

The problem will be investigated when the SAE J227a C cycle test is repeated.

13/ ABNORMAL FACTORS AFFECTING RESULTS

13.1/ Service Days

The number of days the two EVs were in full-day service was averaged to be 78% of potential service days. An examination of Table 3 shows that switching drivers, and testing on the dynamometer were two major causes for keeping the vehicles out of the courier service. Heater repair kept the EV12 out of service for six days. In the future, the switching of drivers and of vehicle starting points will be minimized. Vehicle testing on dynamometer will be limited to no more than once in each six-month period.

13.2/ Energy Consumption

When the two EVs were not in service, they were plugged into the chargers. The charger turns on for about one-half hour in every six-hour period after the traction battery is fully charged, thus providing a trickle charge. The energy consumed by the trickle charge does not further increase the energy of the traction battery. It merely compensates the energy loss due to self-discharge, while the vehicle is not in use. Therefore, increasing the number of days the two EVs are in full-day service will, in effect, decrease the energy consumption per unit distance travelled.

13.3/ Labour Cost

The time taken for the mechanics to trouble-shoot and repair defects on initial failures was significantly longer than the time taken on subsequent similar failures. This trend will continue and lead to lower maintenance labour costs.

13.4/ Water Consumption

A component malfunction on the electronic printed circuit board of the watering trolley was not discovered until after this reporting period. That problem made the water consumption figure much higher than it should be.

14/ CONCLUSION

For the period from May 14, 1986 to November 13, 1986, the total mileage logged by the two EVs was 22 361 km (13 931 miles).

EV11 was in full service for 106 out of 126 days and EV12 was in full service for 91 out of 126 days. The electricity cost was 1.88¢/km. The operation cost which consists of electricity, heater fuel, battery water, and maintenance labour was 11.95¢/km.

The ride quality of the two EVs was not as good as the propane vans they replaced. The passenger survey showed that 71% of the passengers considered the ride uncomfortable, however, 85% of the passengers surveyed were in favour of the demonstration program conducted by this ministry.

Table 1/ Courier Service Schedule

Leave Downsview (Main Entrance, East Building)	Leave Garage (881 Bay Street)
8:30 am	8:30 am
10:00 am	10:00 am
11:30 am	11:30 am
1:00 pm	1:00 pm
2:30 pm	2:30 pm
3:30 pm	3:30 pm

Table 2/ Operation Data of EV11 and EV12

Period: from May 14, 1986 to November 13, 1986

	EV11	EV12
Number of days -- total	184	184
Potential service days	126	126
Total accumulated distance km(mi)	11 503(7184)	10 858 (6747)
Number of days vehicle completed a full day service	106	91
Accumulated distance from full-day services km (mi)	10 658(6623)	9004(5595)
Mean daily distance for a full-day service km (mi)	100(62.48)	99(61.48)
Mean daily ac energy consumption for a full-day service (kWh)	48.25	47.95
Mean ac energy consumption per unit distance for a full-day service kWh/km (kWh/mi)	0.48(0.77)	0.48(0.78)
Total number of weekend days and holidays	58	58
Mean ac energy consumption on weekend days (kWh/day)	2.37	2.32
Total number of days vehicles did not complete a full-day service or was not in service	20	35
Overall mean ac energy consumption per unit distance kWh/km (kWh/mi)	0.50(0.80)	0.49(0.79)
Energy cost per unit distance ¢/km (¢/mi)	1.90(3.04)	1.86(3.00)

Table 3/ Causes for Loss of Full-Day Service

	EV11	EV12
Switching Drivers	5	5
Driver Absenteeism	N/A	3
Publicity Work	2	2
Test Run	2	1
Dynamometer Test	5	9
Accident	1	N/A
Mechanical System Repair	3	4
Heater Repair	N/A	6
Brake System Repair	2	3
Battery Pack Watering System	N/A	1
Drive Control System	N/A	1
Total	20	35

Notes for Table 3

Switching drivers - Usually the vehicle will miss one or two trips of the day.

Driver Absenteeism - When the driver was absent without advance notice, the fill-in driver usually picked up the vehicle available to him instead of the EV.

Publicity Work - The vehicles were taken out of service to have logos painted and to present the vehicle for showing purposes.

Heater Repair - The actual repair was done in one day. The other five days were lost in waiting for the repair appointment.

The actual number of days the vehicles were pulled from full service due to the electric drive system problems were

1/ Heater repair	one day
2/ Brake system	two days
3/ Battery-pack watering system	one day
4/ Drive control system	one day
Total	five days

Table 4/ Energy Consumption vs Drivers

	EV11			EV12		
	Driver 1	Driver 2	Overall	Driver 1	Driver 2	Overall
No. of sampling days	23	33	106	9	21	91
Average daily distance (km)	106.4	97.7	100.6	106.8	97.3	98.9
Average daily opportunity charge input (kWh ac)	6.999	7.741	7.506	7.493	6.705	7.244
Average daily ac energy consumption (kWh ac)	50.252	47.071	48.250	48.910	46.361	47.950
Average ac energy consumption per unit distance (kWh/km)	0.47	0.48	0.48	0.46	0.48	0.48

Table 5/ Battery Pack Water Consumption from May 14, 1986 to November 13, 1986

Vehicle	EV11	EV12
Number of fill-ups	14	14
Total water consumption	96.8 L	105.5 L
Mean water consumption per fill-up	6.91 L	7.54 L
Water consumption per unit distance	8.42 mL/km (13.47 mL/mi)	9.72 mL/km (15.64 mL/mi)
Cost of water	$40.19	$43.81
Cost of water per unit distance	0.35¢/km (0.56¢/mi)	0.40¢/km (0.65¢/mi)
Mean cost of water per unit distance	0.38¢/km (0.60¢/mi)	

Table 6/ Labour Cost on Maintenance and Repair

Item	Man-hour		Cost per Unit Distance	
	Total	Cost*	¢/km	¢/mi
Battery Pack Watering	9.33	$ 326.55	1.46	2.34
Traction Motor Inspection	12.00	420.00	1.88	3.01
Brake Vacuum Pump Repair	16.00	560.00	2.50	4.02
Battery Pack Watering System Repair	8.00	280.00	1.25	2.01
Drive Control System Repair	8.00	280.00	1.25	2.01
Heater Repair**	8.00	280.00	1.25	2.01
Total	61.33	$2146.55	9.59	15.40

*Labour costs were calculated based on $35/h rate.

**The heater repair was under warranty. The man-hour cost accounted here was the time spent by the mechanics to drive the vehicle back and forth to the dealer for the repair.

Table 7/ Operation Cost

Vehicle	EV11		EV12		EVs		% of overall
	Total $	per km ¢/km	Total $	per km ¢/km	Total $	per km ¢/km	%
Electricity	218.39	1.90	202.55	1.86	420.94	1.88	15.7
Heater Fuel	10.00	0.09	10.00	0.09	20.00	0.09	0.8
Battery Water	40.19	0.35	43.81	0.40	84.00	0.36	3.0
Maintenance Labour	597.45	5.19	549.10	14.27	2146.55	9.60	80.3
Overall	866.03	7.53	1805.46	16.63	2671.49	11.95	100.0

NOTE: The electricity cost was based on 3.80¢/kWh, and the maintenance labour cost was based on $35/man-hour.

Table 8/ Passenger Survey Findings

Question No.*	Number of Answers											
	Group 1			Group 2			Group 3			Overall		
	Yes	No	Neu.	Yes	No	Neu.	Yes	No	Neu.	Yes	No	Neu.
2	16	3	1	4	0	0	2	4	1	22	7	2
3	15	3	0	3	1	0	6	0	0	24	4	0
4	14	3	0	1	3	0	4	3	0	19	9	0
5	6	9	2	0	4	0	0	7	0	6	20	2
6	12	0	1	3	1	0	5	2	0	20	3	1
7	15	0	1	3	1	0	5	2	0	23	3	1
8	2	10	2	0	3	1	1	3	0	3	16	3

Question No.	In Percentage											
	Group 1			Group 2			Group 3			Overall		
	Yes	No	Neu.	Yes	No	Neu.	Yes	No	Neu.	Yes	No	Neu.
2	80	15	5	100	0	0	29	57	14	71	23	6
3	83	17	0	75	25	0	100	0	0	86	14	0
4	82	18	0	25	75	0	57	43	0	68	32	0
5	35	53	12	0	100	0	0	100	0	21	71	8
6	92	0	8	75	25	0	71	29	0	83	13	4
7	94	0	6	75	25	0	71	29	0	85	11	4
8	14	72	14	0	75	25	25	75	0	14	72	14

* Questions are listed in Appendix B

Table 9/ Dynamometer Test

	SAE J227a C Cycle		56 km/h (35 mph) Constant Speed Range
	EV11	EV12	EV12
Distance	88.51 km	86.26 km	142 km
No. of cycles completed	160	160	
Total dc energy output kWh	29,622	27,939	29,783
Total AH output	153.8	139.7	
dc energy consumption	185 Wh/cycle 335 Wh/km	175 Wh/cycle 324 Wh/km	210 Wh/km

Notes: Dynamometer Setting: Equivalent Moment of Inertia 3063 kg
Total Resistance Power 12.682 kW

Mean outputs from traction battery at 35 mph constant speed:
11.5 kW, 52.4 A

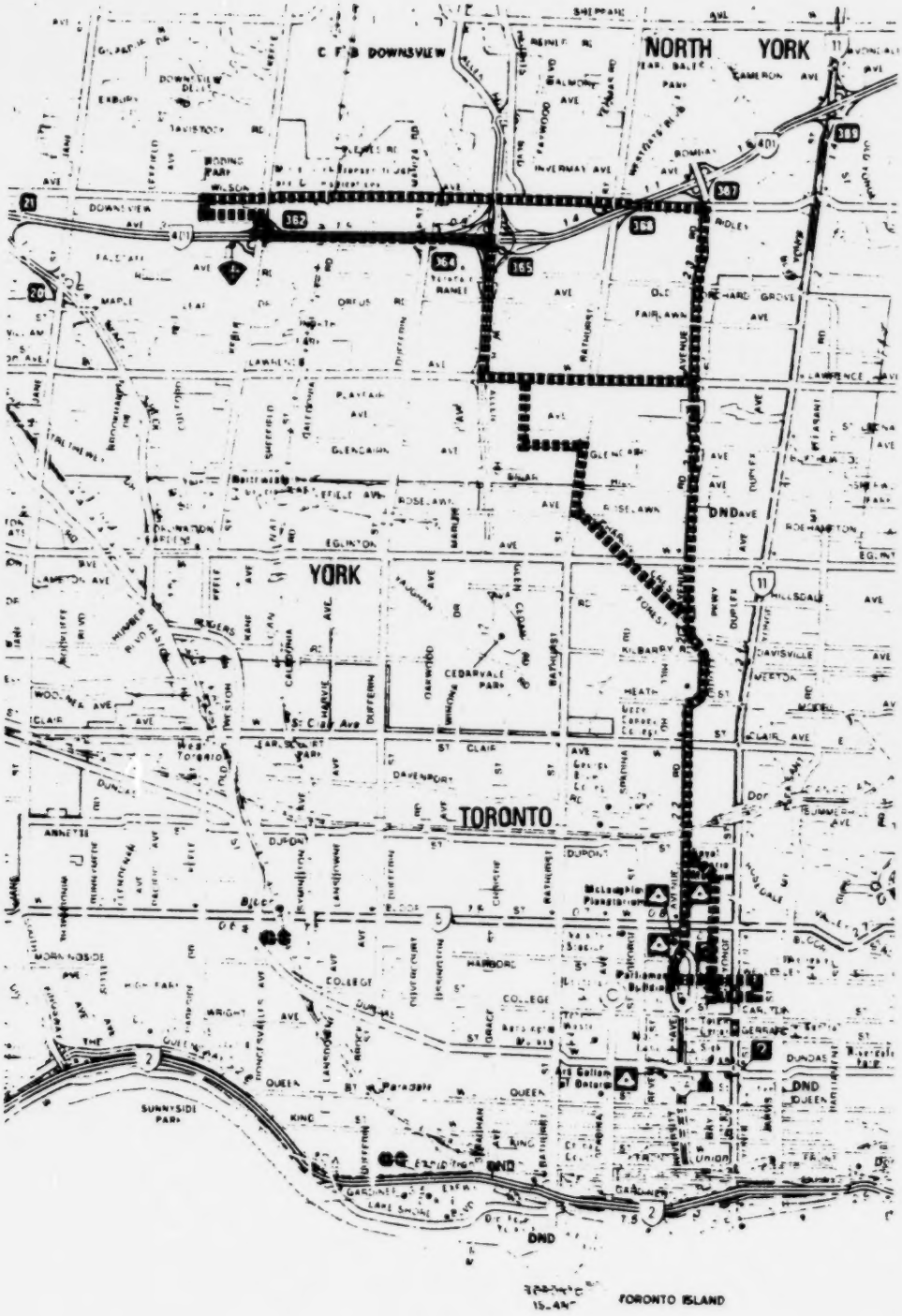
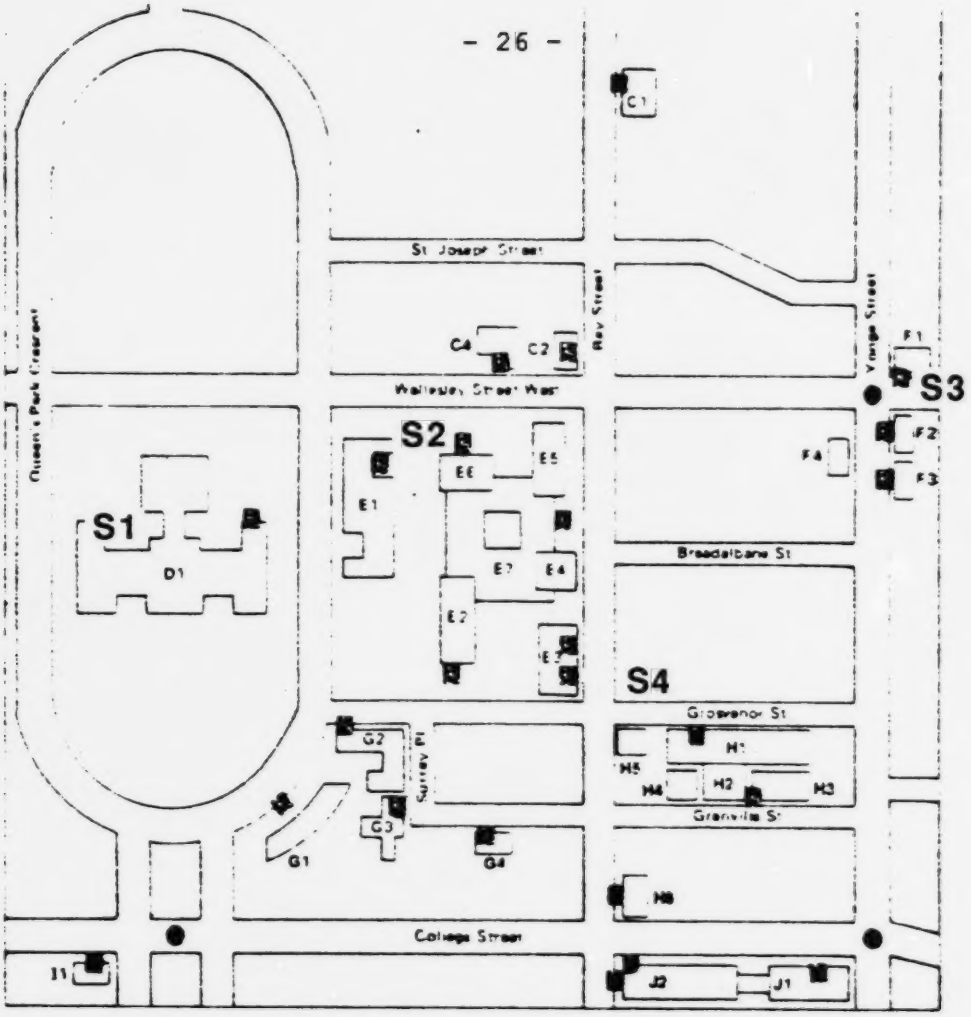
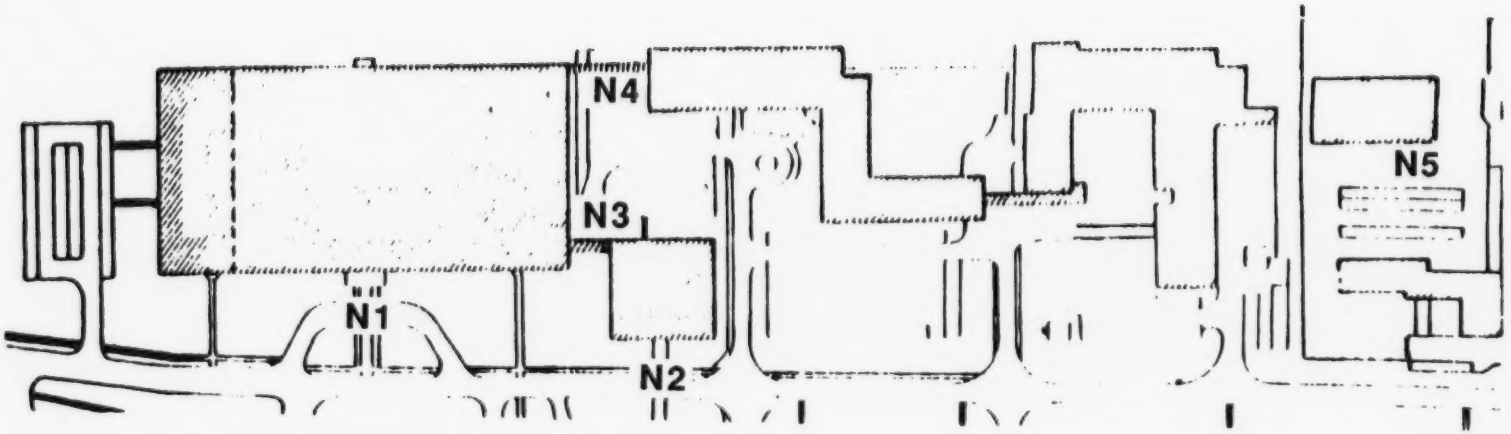


Figure 1/ Courier Service Route



Stops: S1 – Legislative Building
S2 – Ferguson Block
S3 – 10 Wellesley St. E.
S4 – Government Repair Garage

Figure 2/ Courier Service Regular Stops – Queen's Park Area



Stops: N1 – Main Entrance, East Bldg.
N2 – Main Entrance, West Tower
N3 – Receiving Dock, East Bldg.
N4 – East Entrance, Central Bldg.
N5 – South Garage, District 42

Figure 3/ Courier Service Regular Stops – MTC Downsview Complex

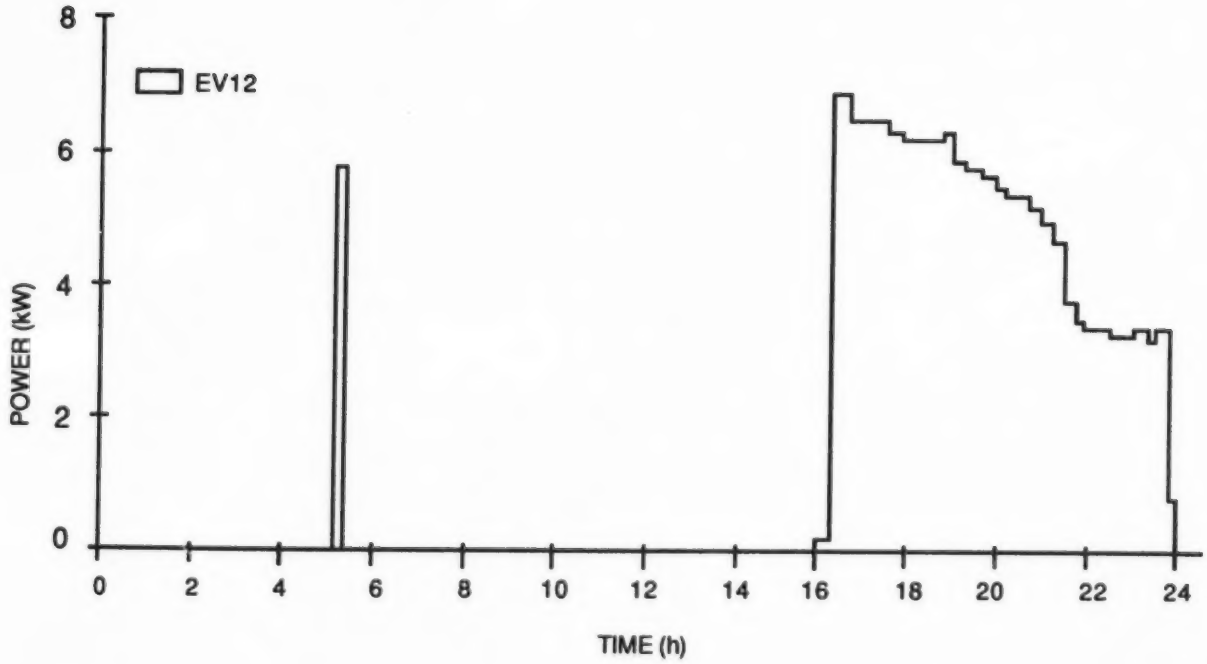


Figure 4/ Power Demand at District 42 Charger, July 10, 1986
Total Energy 39.8 kWh

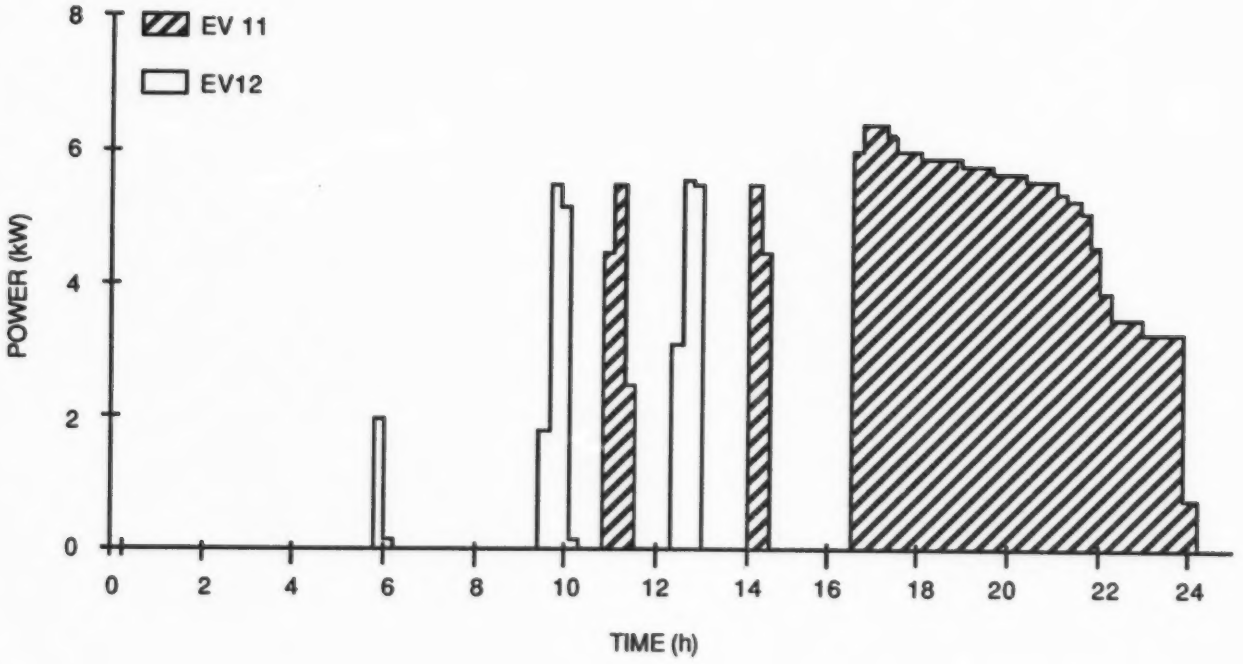


Figure 5/ Power Demand at Government Garage Charger, July 10, 1986
Total Energy 54.7 kWh

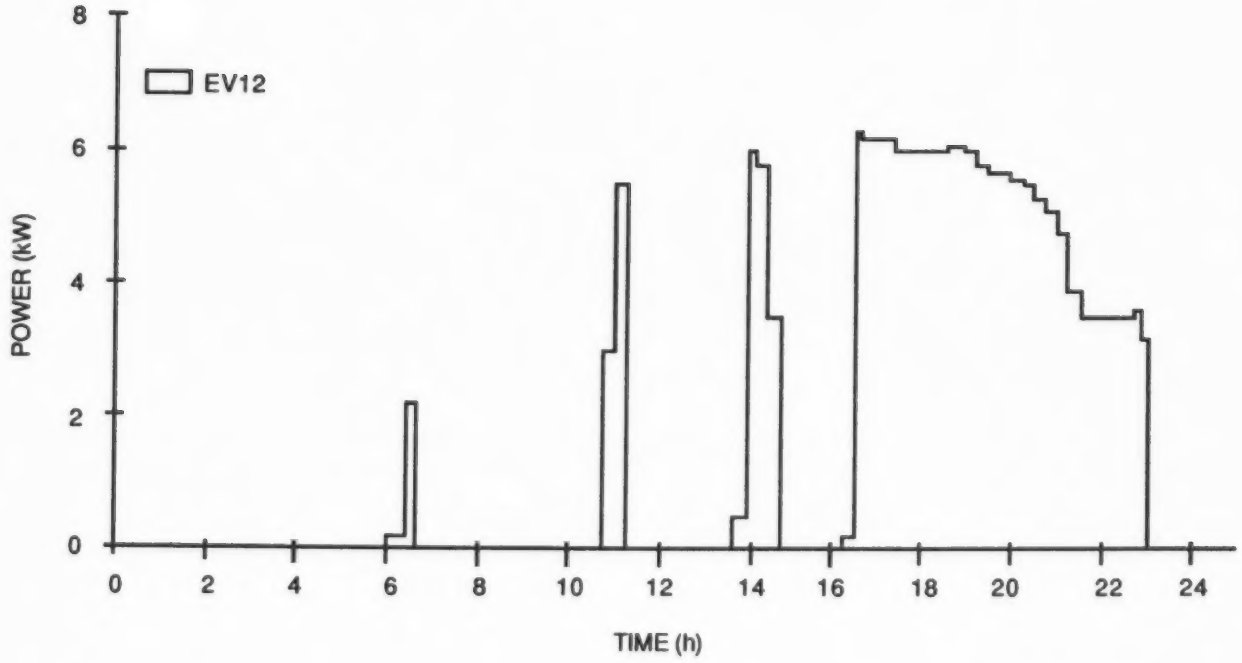


Figure 6/ Power Demand at District 42 Charger, July 23, 1986
Total Energy 40.6 kWh

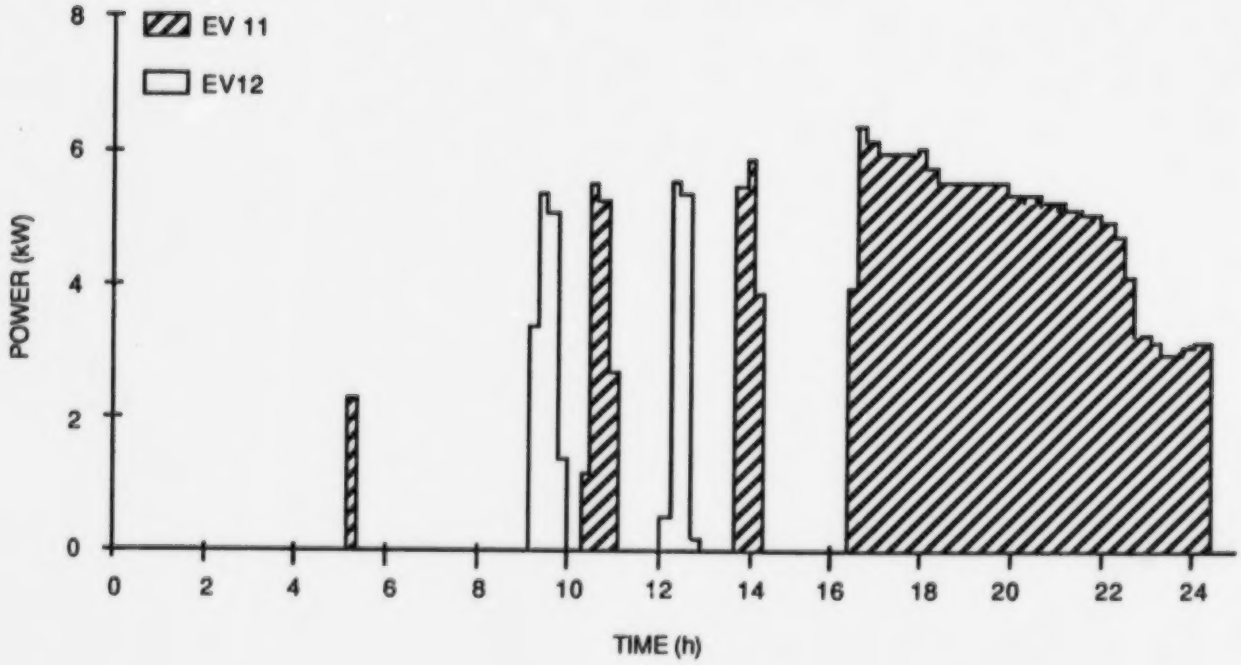


Figure 7/ Power Demand at Government Garage Charger, July 23, 1986
Total Energy 55.0 kWh

REFERENCES

[1] Hsu, D., Duncan, J., "Electric Vans -- Progress Report," Transportation Technology and Energy Branch Report EV-86-01, Ontario Ministry of Transportation and Communications, October 1986.

[2] Barnett, J.H., "Test and Evaluation Report for the Bedford CF Electric Van," EPRI Research Project 1136-17, April 1985.

APPENDIX A/ Load Research Records

A.1/ Load Summary

```
COMPLETION REPORT FOR ID: 0101720140          0                    1986/ 9

MTC-ONT GVT CAR      881 BAY ST-TORONTO   CART # 107298
CLASS OF ACCOUNT: M332

15 MIN. /  36 DAY TAPE -LOP     NORMAL   TRANSLATION ON 1986/ 8/22 10:28

                ********** M E T E R **********              DECK.   1

                    KWH                                      FILE:  CW
                    -A-          -B-          -C-            LU: -12
                                                            T-CHAN:  NO
START:             245.0          0.0          0.0
STOP:              358.0          0.0          0.0        JOB ENTRY:  77
NET:               113.0          0.0          0.0
MULT:               10.0          0.0          0.0
T O T A L         1130.0          0.0          0.0

PULSES:           156437            0            0
MULT:           .007200     0.000000     0.000000
T O T A L         1126.3          0.0          0.0

PEAK PULSES          229            0            0

PEAK DEMAND          6.6          0.0          0.0
PEAK DAY/TIME  8/ 7 15:15   0/ 0  0: 0   0/ 0  0: 0
LOAD FACTOR          .217        0.000        0.000
# ZERO INTS         2065            0            0

D I F F              3.7          0.0          0.0
%   D I F F        36.5381       0.0000       0.0000
(TOL. = 100.0000)
-------------------------------------------------------------------------
CART. START:      86/ 7/16  7:10      CART. STOP:86/ 8/18  6:44
                                      CALC. STOP:86/ 8/18  6:45

TIME INTERVALS FOUND          3167    REAL + INSERTED + OUTAGES
TIME INTERVALS EXPECTED       3167
TIME INTERVALS DIFFERENCE        0    FOUND - EXPECTED

  CHAN   FIRST 4 INTERVALS          LAST 4 INTERVALS
   A      3     0     0     0        0     0     0     0

* * * * T R A N S L A T I O N    A C C E P T E D
```

DDR LOCATION # 0101720140 CUST. 0 A ENGINEERING UNITS REPORT - KW ANALYSIS CLASS M332 PAGE: 1
MTC-ONT GVT GAP 881 BAY ST-TOPONTO 10:10 AM TUE., 2 SEPT, 1986 BILLING PERIOD: 86/07/16 07:10 TO 86/08/18 06:45

	15	30	45	60	15	30	45	60	15	30	45	60	
0 *	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	*
3 *	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	*
6 *	.0	.0	.0	.0	.1M	.0	.0	.0	3.2	5.6	4.9	.0	*
9 *	.0	.0	.0	.0	.0	.0	.0	.0	5.1	5.7	5.5	.1	*
12 *	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	2.7	*
15 *	5.7	5.6	5.6	5.6	5.5	5.5	5.4	5.3	5.2	5.1	5.0	4.7	*
18 *	4.1	2.9	2.6	2.7	2.6	2.7	2.8	2.7	2.7	.0	.0	.0	*
21 *	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	*
* DAILY PEAK: 15:15			5.7 KW			ENERGY KWH		30.7			WEDNESDAY	86/07/16	*
0 *	.0	.0	.0	.0	.0	.0	.0	1.7	.6	.0	.0	.0	*
3 *	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	*
6 *	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	*
9 *	.0	.0	4.6	5.4	5.0	.0	.0	.0	.0	.0	.0	.0	*
12 *	.0	.5	5.7	5.6	3.9	.0	.0	.0	.0	.0	.0	.0	*
15 *	6.3	6.3	6.2	6.2	5.9	5.8	5.7	5.7	5.7	5.8	5.8	4.3	*
18 *	5.4	5.4	5.3	5.2	5.2	5.2	5.0	4.6	4.1	3.3	2.9	5.7	*
21 *	3.0	3.1	2.9	2.8	.1	.0	.0	.0	.0	.0	.0	3.0	*
* DAILY PEAK: 15:15			6.3 KW			ENERGY KWH		43.5			THURSDAY	86/07/17	*
0 *	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	*
3 *	.0	.0	1.3	.8	.0	.0	.0	.0	.0	.0	.0	.0	*
6 *	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	*
9 *	.0	.0	3.6	5.4	4.6	.0	.0	.0	2.7	4.9	5.1	.0	*
12 *	.0	1.6	5.9	5.8	5.1	.0	.0	.0	.0	5.4	5.4	.3	*
15 *	6.2	6.2	6.0	5.8	5.8	5.9	5.9	5.8	5.8	.0	.0	4.3	*
18 *	5.4	5.2	5.2	5.2	5.2	5.0	4.9	4.6	3.9	5.7	5.8	5.7	*
21 *	2.9	3.1	3.0	2.9	1.0	.0	.0	.0	.0	3.1	2.9	2.9	*
* DAILY PEAK: 15:30			6.2 KW			ENERGY KWH		49.7			FRIDAY	86/07/18	*
0 *	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	*
3 *	.0	.0	.5	1.8	.0	.0	.0	.0	.0	.0	.0	.0	*
6 *	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	*
9 *	.0	.0	2.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	*
12 *	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	*
15 *	.0	2.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	*
18 *	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	*
21 *	1.4	.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	*
* DAILY PEAK: 15:30			2.1 KW			ENERGY KWH		2.1			SATURDAY	86/07/19	*
0 *	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.9	*
3 *	1.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	*
6 *	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.3	1.7	*
9 *	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	*
12 *	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	2.0	.0	*
15 *	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	*
18 *	.0	.0	.0	.0	.0	.0	.0	.0	.0	1.3	.2	.0	*
21 *	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	*
* DAILY PEAK: 14:45			2.0 KW			ENERGY KWH		2.0			SUNDAY	86/07/20	*

TOTAL DUMP ID: 0101720140 MULT: .00720 CHAN-A KWH DUMP PERIOD: 86/07/16 07:15 86/09/ 2
15 MIN / 036 DAY TAPE-LOG CAPT: 107218 OFFS: .00000 NORMAL TRANS ON 86/08/22 10:20 TO 86/08/18 06:45 PAGE 1
MTC-ONT GVT GAR 881 BAY ST-TORONTO 0

0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	***DATE***	
							3M	111	0	0	176	0	0	0	198	192	173	144	92	94	0	0	0	WED	7/16
							0	193	0	0	198	0	0	0	196	190	176	101	95	0	0	0	0	TOT	004241
							0	169	0	0	191	0	0	0	195	186	172	91	96	0	0	0	0	11:30	199
							0	0	0	0	2	0	0	94	194	193	163	93	94	0	0	0	0		
0	0	20	0	0	0	0	0	0	0	172	0	0	136	0	219	205	199	199	180	141	104	5	0	THU	7/17
0	0	0	0	0	0	0	0	0	0	0	0	19	0	0	218	201	200	187	179	115	107	0	0	TOT	006047
0	0	0	0	0	0	0	0	0	139	0	0	197	0	0	215	197	201	183	175	101	99	0	0	15:15	219
0	59	0	0	0	0	0	0	0	199	0	0	195	0	151	215	199	199	191	159	103	97	0	0		
0	0	0	0	0	0	0	0	0	0	159	95	0	176	0	215	202	201	199	179	134	101	34	0	FRI	7/18
0	0	0	0	0	0	0	0	165	0	0	197	54	0	0	217	205	199	182	174	106	106	0	0	TOT	006909
0	0	0	46	0	0	0	0	178	126	0	199	205	0	0	210	206	200	181	169	99	104	0	0	15:30	217
0	0	0	29	0	0	0	0	0	197	0	11	201	0	149	201	202	199	179	159	99	102	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	0	0	0	SAT	7/19
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	72	0	0	0	0	0	19	0	0	TOT	000230
0	0	0	17	0	0	0	0	0	69	0	0	0	0	0	1	0	0	0	0	0	0	0	0	15:30	72
0	0	0	62	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	41	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	SUN	7/20
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	66	0	0	0	TOT	000294
0	0	0	0	0	0	0	0	10	0	0	0	0	0	69	0	0	0	0	0	7	0	0	0	14:45	69
0	0	32	0	0	0	0	0	59	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	46	0	0	0	0	0	23	0	160	191	0	212	157	193	211	196	206	193	174	104	107	0	MON	7/21
0	0	29	0	0	0	0	0	203	0	0	210	0	40	0	219	210	197	201	194	167	101	107	0	TOT	007691
0	0	0	0	0	0	0	0	165	14	0	162	109	0	0	212	211	204	199	192	156	103	107	0	15:30	219
0	0	0	0	0	0	0	0	0	213	0	0	216	101	0	211	210	204	198	179	125	106	64	0		
0	0	0	0	0	0	0	0	0	0	142	141	0	166	0	150	200	200	180	179	154	102	103	0	TUE	7/22
0	0	0	0	0	0	0	0	174	4	0	193	0	0	0	205	199	201	182	175	133	102	101	0	TOT	006814
0	0	0	0	78	0	0	0	133	204	0	67	161	0	0	204	199	203	183	170	111	103	65	0	15:30	205
0	0	0	0	1	0	0	0	0	196	0	0	193	0	0	202	200	200	181	163	107	104	1	0		
0	0	0	0	0	0	0	0	117	0	95	19	0	136	0	0	209	202	195	196	182	167	104	110	WED	7/23
0	0	0	0	79	0	0	0	196	41	0	193	0	0	0	140	210	194	196	187	177	145	106	58	TOT	007634
0	0	0	0	0	0	0	0	178	192	0	183	192	0	0	222	209	194	196	185	178	116	110	1	15:45	222
0	0	0	0	0	0	0	0	47	185	0	8	204	0	0	215	212	196	183	183	175	112	112	0		
0	0	0	0	0	76	0	0	18	0	0	134	0	0	0	209	202	196	191	186	169	110	110	0	THU	7/24
0	0	0	0	0	0	0	0	184	0	173	200	0	0	0	207	204	190	182	183	156	104	110	0	TOT	004651
0	0	0	0	0	0	0	0	167	0	199	177	0	0	0	206	204	191	195	177	124	102	5	0	15:15	203
0	0	0	0	0	0	0	0	0	0	197	0	0	0	37	207	201	191	189	172	116	108	1	0		
0	0	0	0	42	0	0	0	140	0	167	184	0	149	0	192	207	198	197	182	160	101	103	0	FRI	7/25
0	0	0	0	37	0	0	0	186	0	0	189	0	0	0	211	204	198	195	173	132	100	109	0	TOT	007035
0	0	0	0	1	0	0	0	165	142	0	147	52	0	0	209	204	197	195	175	107	98	54	0	15:30	211
0	0	0	0	0	0	0	0	0	186	0	0	192	0	0	207	202	199	194	170	107	100	1	0		

APPENDIX B/ Passenger Survey Questionnaire

ELECTRIC VAN PASSENGER SURVEY

The vehicle you are riding is powered by DC Electric Traction Motor and Lead-Acid Traction Battery Drive System. The use of the Electric Van in the courier service runs, is one of the projects under the alternative Fuel Program in which the Ministry of Transportation and Communications is participating.

Your feedback of the Electric Van in courier service will certainly enrich the findings of this test. Kindly answer the questionaire as fully as you can. Your cooperation will be greatly appreciated.

If you are a frequent user of the courier service and have filled the questionaire before, return the form.

1. How often do you take the courier van ride?

   A. More than once a week _____

   B. About once a week _____

   C. Occasionally _____

2. Is the side door entrance easy to get through?

   A. Yes _____

   B. No _____

3. Are you satisfied with the vehicle interior?

   A. Yes _____

   B. No _____

4. Are the seats comfortable?

   A. Yes _____

   B. No _____

If your answer is 'NO', please specify.

_____

_____

_____

_____

_____

5. Is the ride comfortable?

A. Yes _____

B. No _____

If your answer is 'NO', please specify.

_____

_____

_____

_____

_____

6. Is the vehicle compartment ventilation sufficient?

A. Yes _____

B. No _____

7. This Electric Vehicle does not emit pollutant into areas it travels. Nor does it make any noise or waste energy while it is at stops. Are you in favor of such test program participated by this Ministry?

A. Yes _____

B. No _____

8. If you had a ride/or rides in the previous courier service vans, propane powered van or normal gasoline powered van, please give comments on the Electric Van as compared with other types.

9. General Comments